FUNDAMENTALS

- Potential energy, kinetic energy, Newton's laws of motion, Brayton cycle;
- The relationship between force, work, power, energy, velocity, acceleration;
- Constructional arrangement and operation of turbojet, turbofan, turboshaft, turboprop.

FUNDAMENTALS

ENERGY

WHAT IS ENERGY

ENABLES PHYSICAL WORK TO BE DONE

IS USED TO PERFORM WORK

FUNDAMENTALS

ENERGY

2 FORMS OF ENERGY
WE NEED TO KNOW

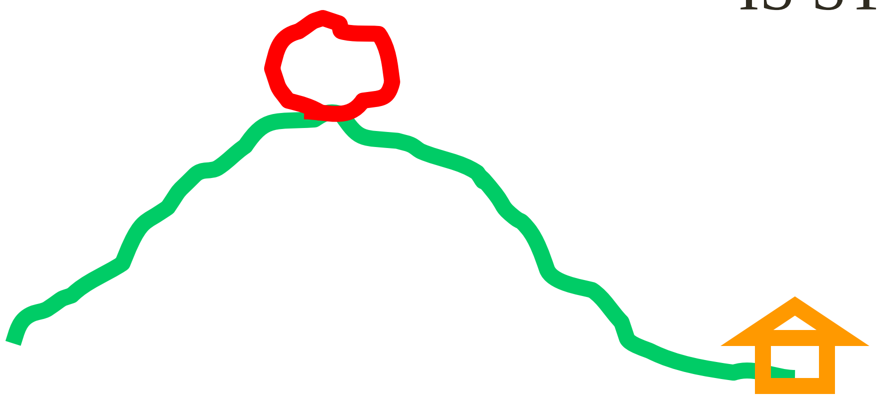
POTENTIAL

KINETIC

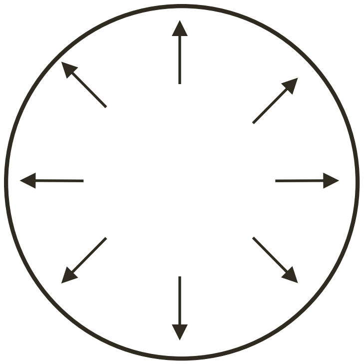
FUNDAMENTALS

POTENTIAL **ENERGY**

IS STORED ENERGY



BOULDER ON
TOP OF A HILL

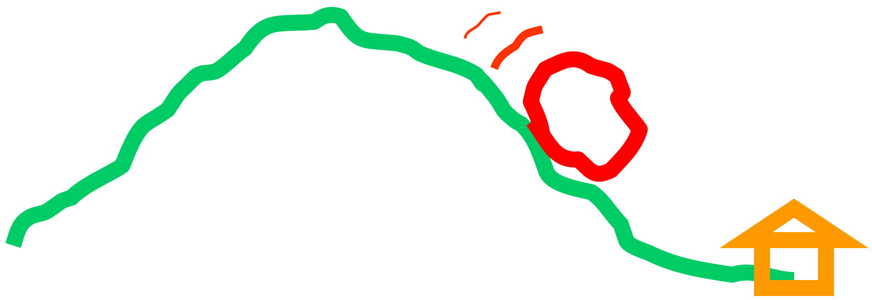


PRESSURISED GAS
IN A VESSEL

(15_1_1b.swf)

FUNDAMENTALS

KINETIC **ENERGY** IS ENERGY IN MOTION

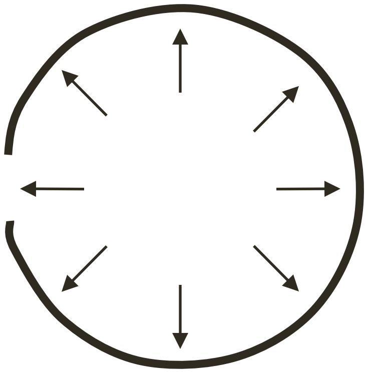


BOULDER ROLLING DOWNHILL

FUNDAMENTALS

KINETIC **ENERGY** IS ENERGY IN MOTION

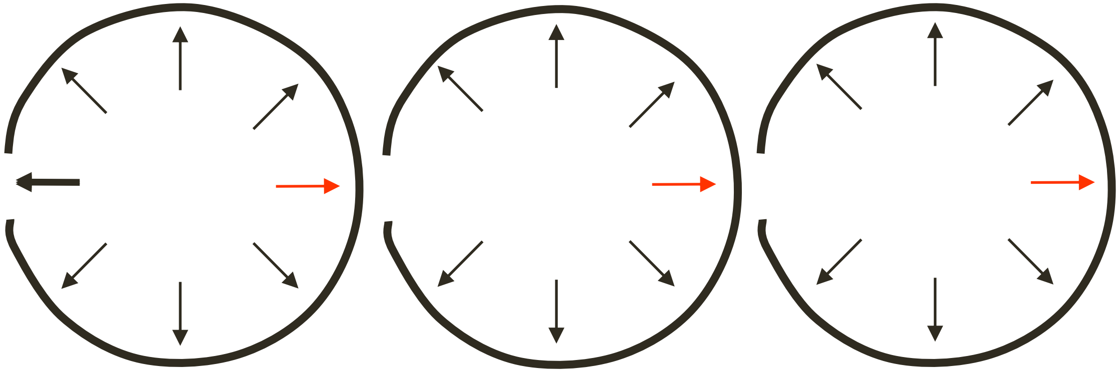
VESSEL
PUNCTURES



FUNDAMENTALS

KINETIC **ENERGY** IS ENERGY IN MOTION

VESSEL
PUNCTURES



(15_1_1c.swf)

FUNDAMENTALS

NEWTON'S LAWS OF MOTION

1.........

2...........

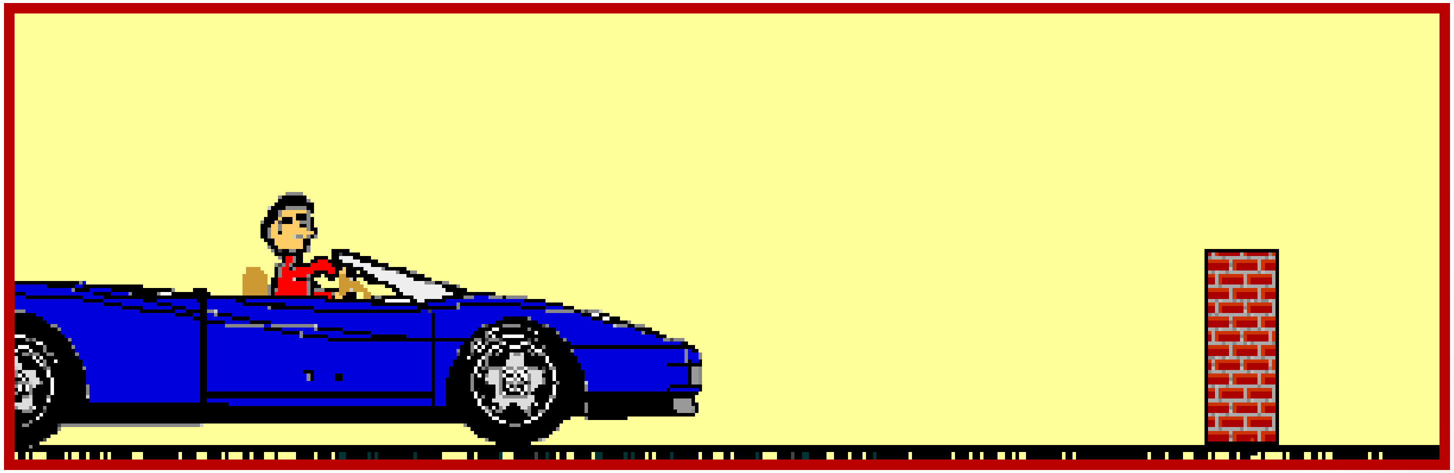
3...................

FUNDAMENTALS

NEWTON'S LAWS OF MOTION

1 First Law

A body at rest tends to remain at rest, and a body in motion tends to remain in motion



(15_1_1da.swf)

FUNDAMENTALS

POLITEKNIK MALAYSIA BANTING

NEWTON'S LAWS OF MOTION

2 Second Law

The relationship between an object's
mass m,
its acceleration a,
and the applied force F
is F = ma.

This is the most powerful of Newton's three Laws, because it allows quantitative calculations of dynamics:

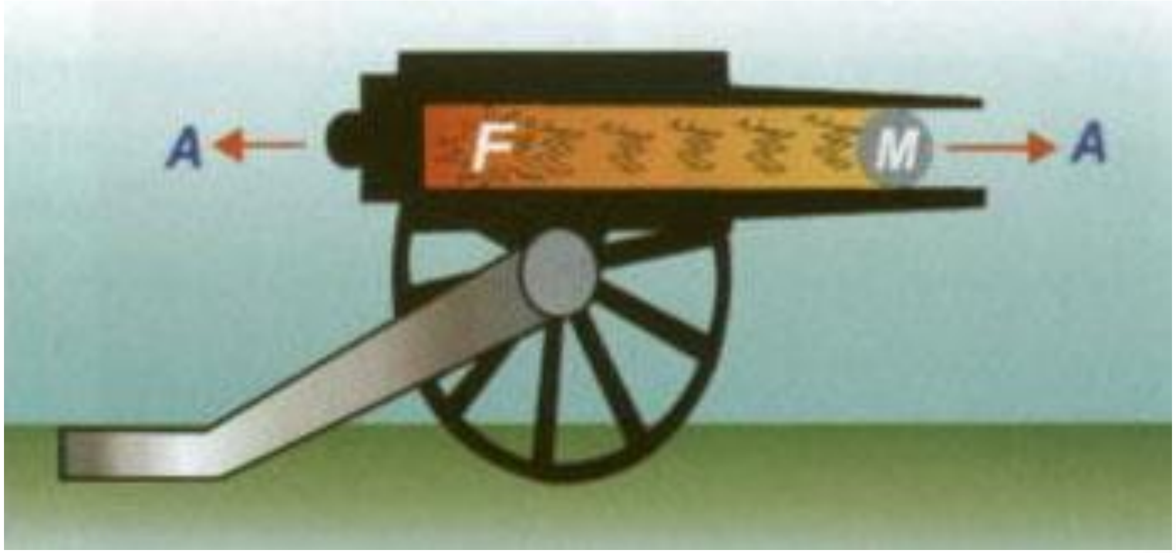
(15_1_1db.swf)

FUNDAMENTALS

NEWTON'S LAWS OF MOTION

3 Third Law

For every action
there is an equal and opposite reaction



FUNDAMENTALS

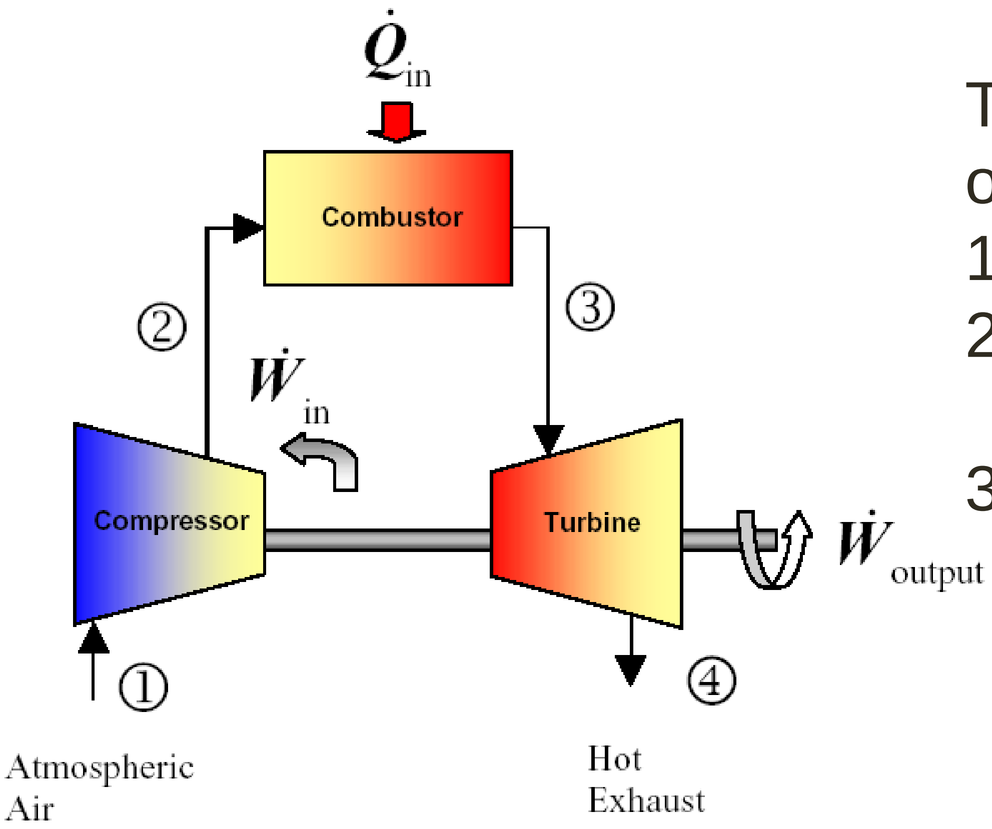
The BRAYTON CYCLE

The Brayton cycle is a cyclic process generally associated with the gas turbine

Also known as a
Constant Pressure Cycle

FUNDAMENTALS

The BRAYTON CYCLE

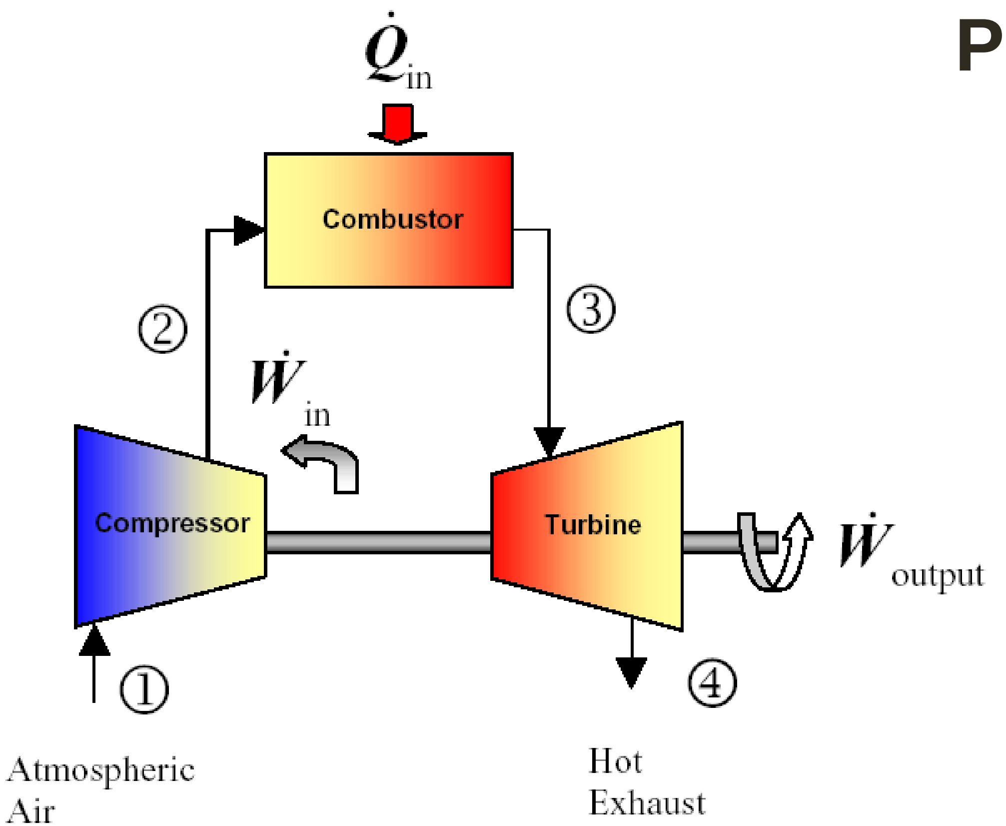


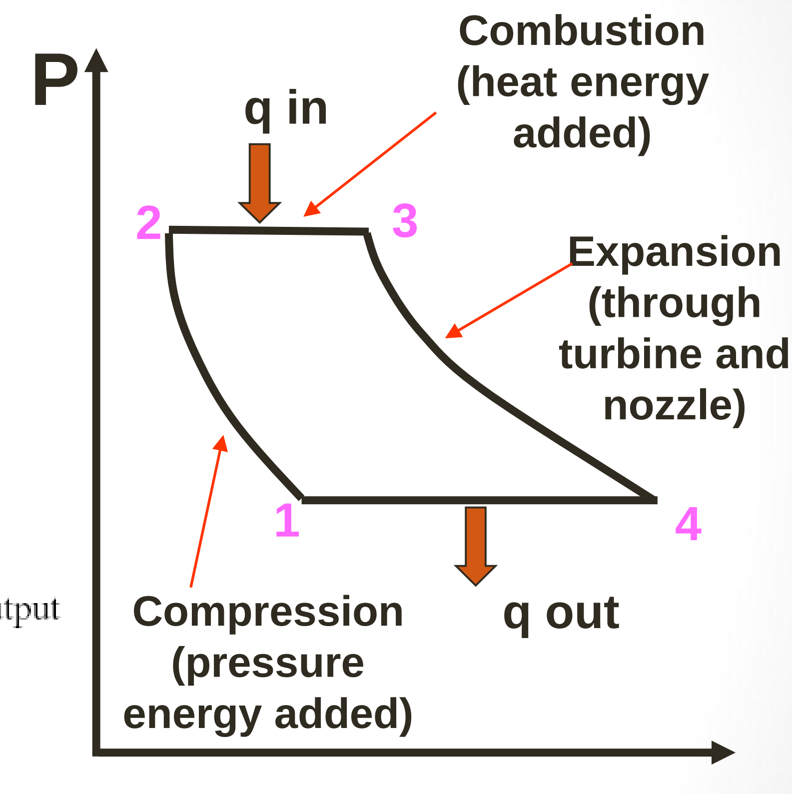
The gas turbine consists of three components:

1. A gas compressor
2. A burner (or combustion chamber)
3. An expansion turbine

FUNDAMENTALS

The BRAYTON CYCLE





P–v Diagram

(15_1_1f.swf)

FUNDAMENTALS

Force

Force is defined as the capacity to do work. It is also a vector quantity that tends to produce acceleration of a body in the direction of its application.

$$F = P \times A$$

where : F = Force in lb

P = Pressure in lb/sq. in.

A = Area in sq. ins.

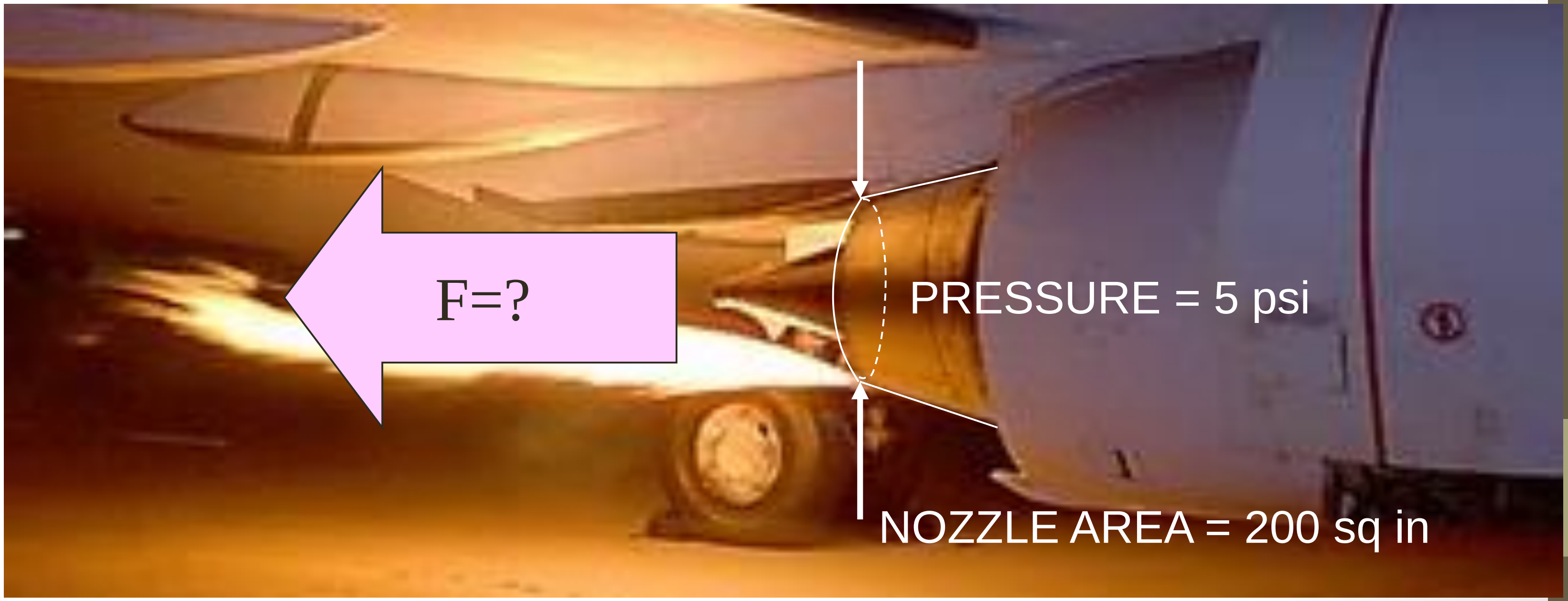
FUNDAMENTALS

$$F = P \times A$$

Force

Example

The pressure across the opening of a jet tailpipe (exhaust nozzle) is 5 psi above ambient, the opening is 200 square inches, what is the force present?



FUNDAMENTALS

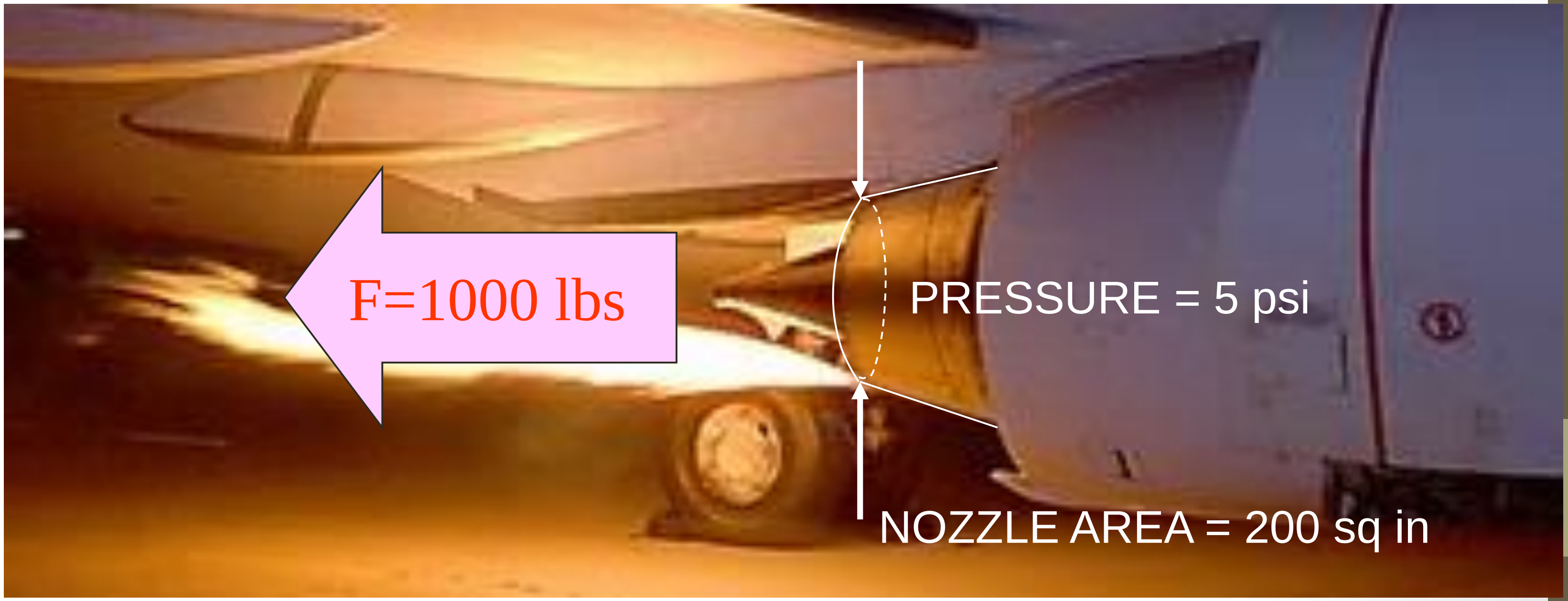
$$F = P \times A$$

Force

where: P = 5 lbs/sq. in. A = 200 sq. in. F = ? lbs

F = 5 X 200

F = 1,000 lbs.



(15_1_2b.swf)

FUNDAMENTALS

Work

Mechanical work is present when a force acting on a body causes it to move through a distance

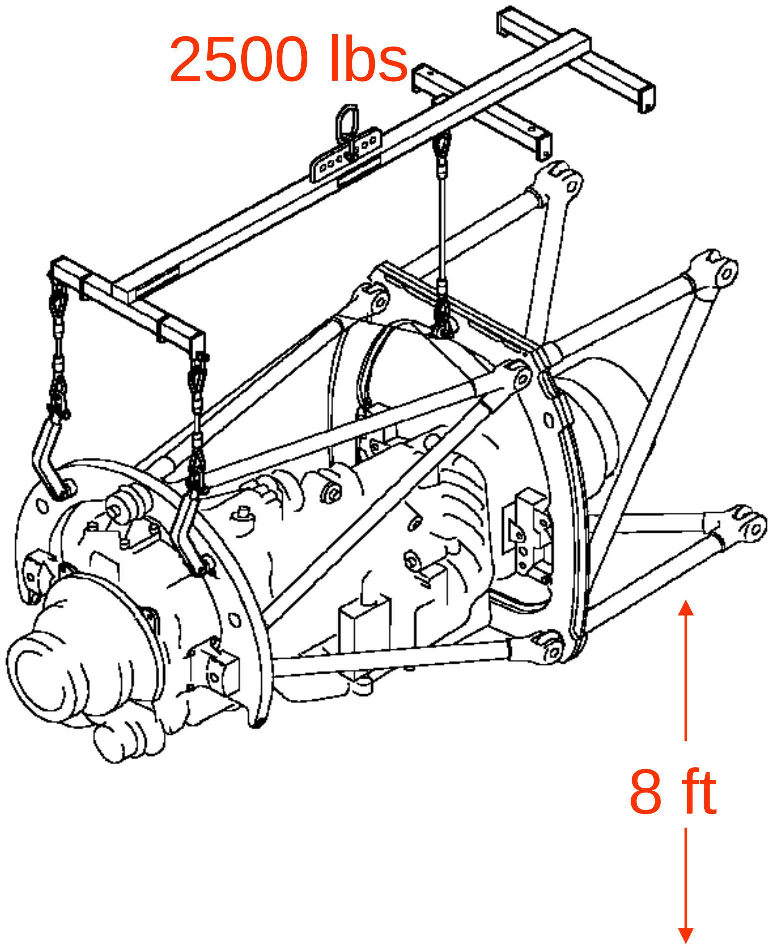
$$W = F \times D$$

where: F = Force in lbs
D = Distance in feet
W = Ft. lbs.

FUNDAMENTALS

$$W = F \times D$$

Work



Example

How much work is performed by a device which lifts a 2,500 lb. engine a height of 8 feet?

POLITEKNIK MALAYSIA BANTING

FUNDAMENTALS

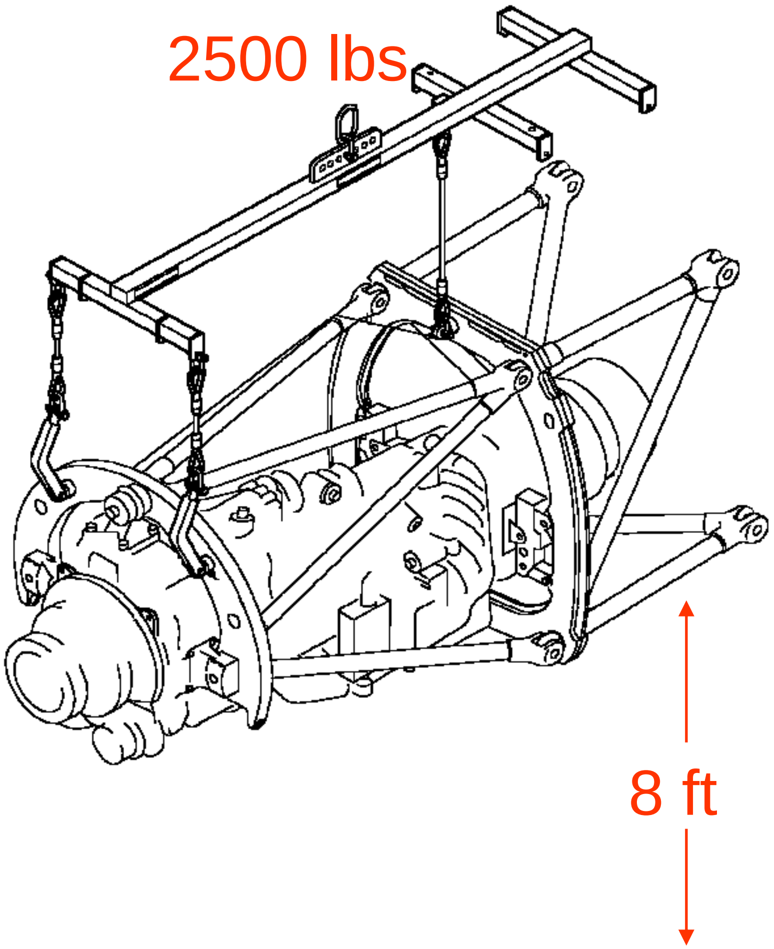
$$W = F \times D$$

Work

where: F = 2,500lbs.

D = 8 ft.

W = ? ft. lbs.



W = 2,500 X 8

W = 20,000 ft. lbs.

FUNDAMENTALS

Power

The definition of work makes no mention of time. Therefore power is the rate of performing work.

$$P = \frac{F \times D}{t}$$

where: F = Force in lbs.

D = Distance in feet

t = Seconds or minutes

P = ft. lbs/sec. or ft. lbs/min.

POLITEKNIK MALAYSIA BANTING

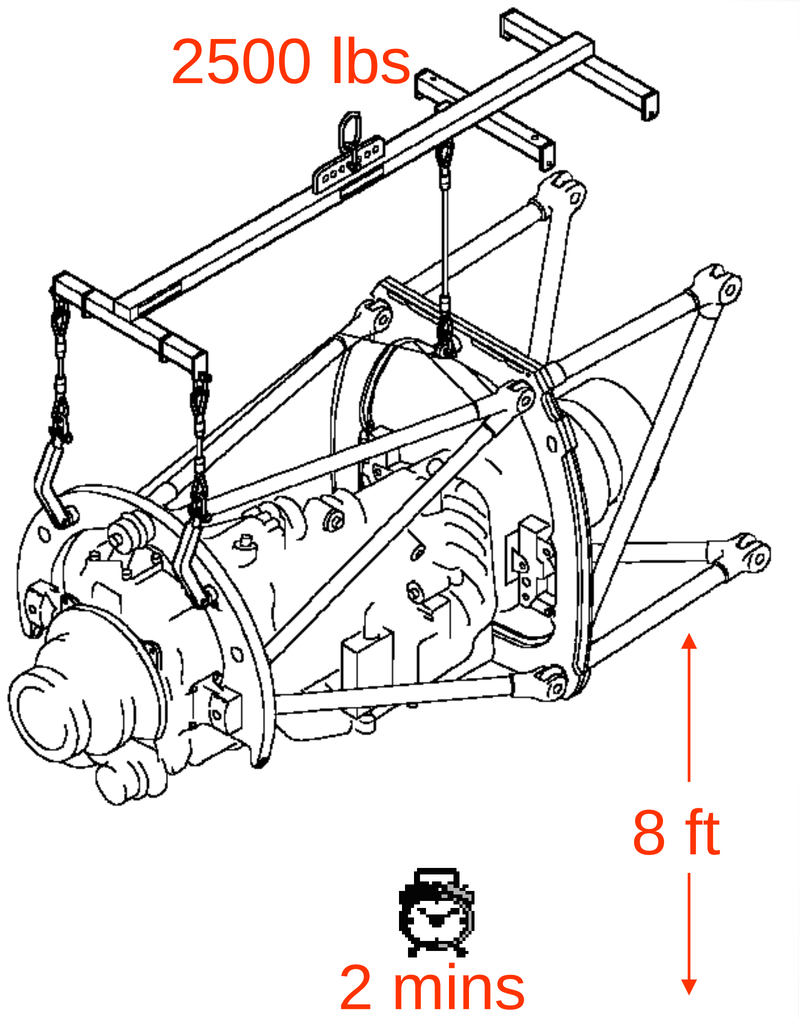
FUNDAMENTALS

$$P = \frac{F \times D}{t}$$

Power

Example

A 2,500 lb. engine is to be hoisted to a height of 8 feet in two minutes. An electrical motor of how much power is required?



FUNDAMENTALS

$$P = \frac{F \times D}{t}$$

Power

where: F=2,500 lbs.

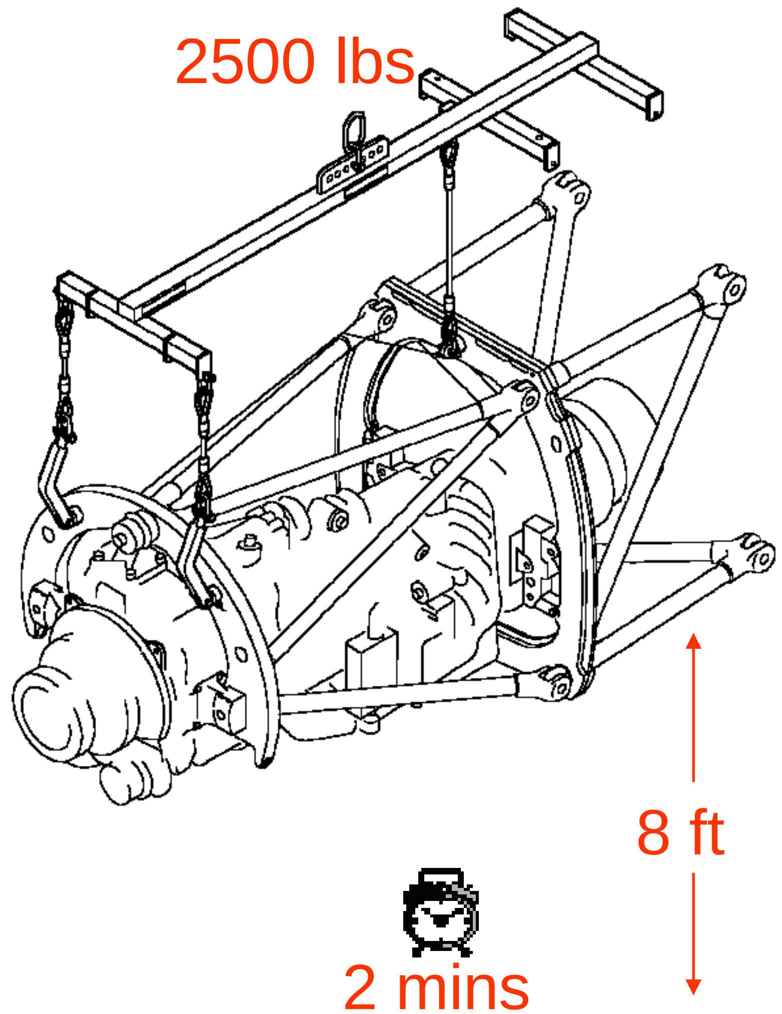
D = 8 ft.

t = 2 mins.

P=? ft. lbs/min.

$$P = \frac{2500 \times 8}{2}$$

P= 10,000 ft.lbs/min.



FUNDAMENTALS

Velocity

Velocity is speed in a given direction

$$V = \frac{D}{t}$$

where: D = Distance in feet or miles

t = Time in seconds or minutes

V = velocity

POLITEKNIK MALAYSIA BANTING

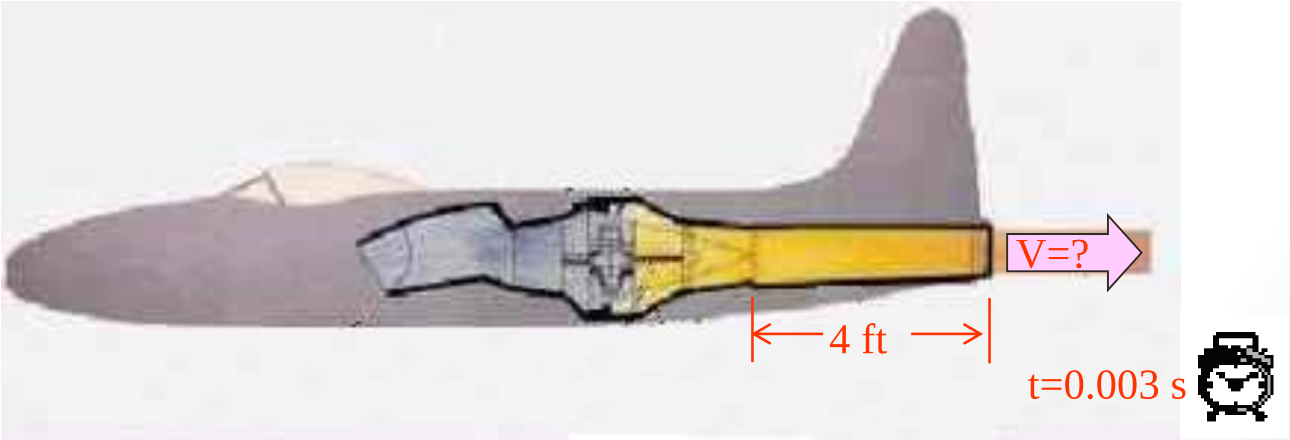
FUNDAMENTALS

Velocity

$$V = \frac{D}{t}$$

Example

Gas flows through a gas turbine engine tailpipe a distance of 4 feet in 0.003 seconds. What is its velocity?



FUNDAMENTALS

Velocity

$$V = \frac{D}{t}$$

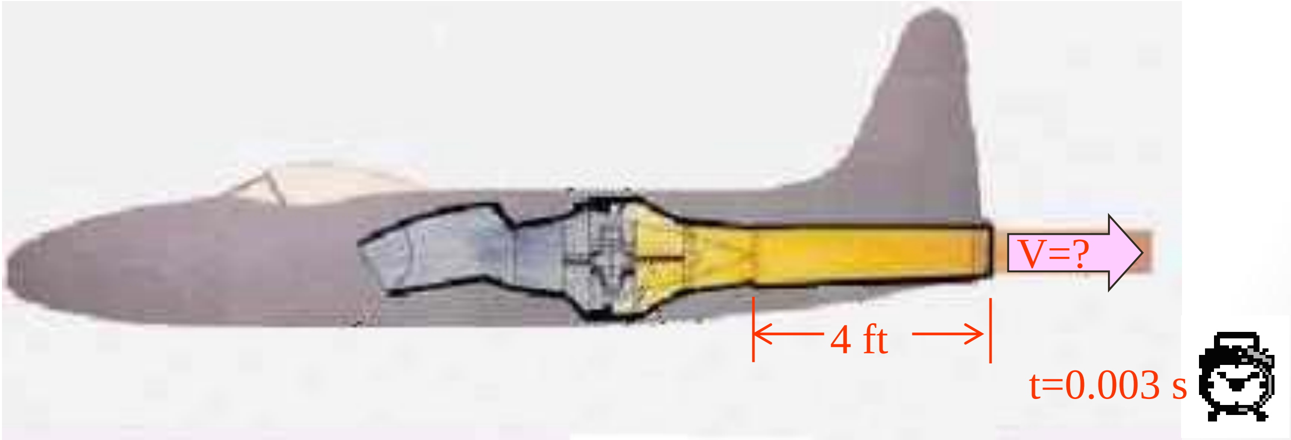
where: D=4 feet

t=0.003seconds

V= ? ft/sec.

$$V = \frac{4}{0.003}$$

V=1,333 ft.per second



(15_1_2e.swf)

FUNDAMENTALS

Acceleration

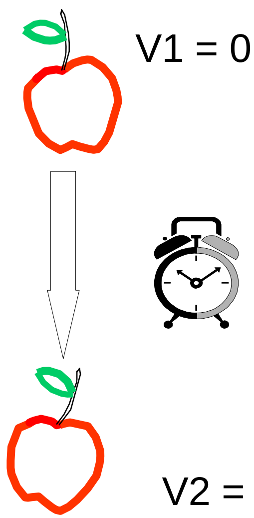
Acceleration is the change of velocity with respect to time

$$acceleration = \frac{FinalVelocity - InitialVelocity}{time\ taken\ for\ changes}$$

$$A = \frac{V2 - V1}{t}$$

FUNDAMENTALS

Acceleration



V1 = 0 FT/SEC

t = 1 SEC

V2 = 32.2 FT/SEC

FINAL VELOCITY (FT/SEC)

INITIAL VELOCITY (FT/SEC)

$$A = \frac{V2 - V1}{t}$$

A: ACCELERATION (FT/SEC/SEC)

t: TIME (SEC)

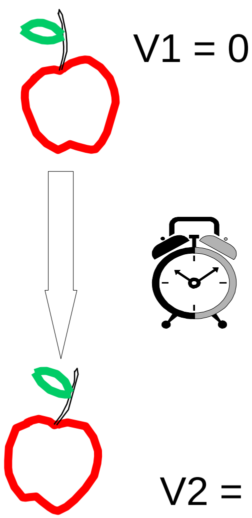
EXAMPLE

A falling apple, begins at 0 ft per sec, reaches 32.2 ft per sec in 1 sec

FUNDAMENTALS

POLITEKNIK MALAYSIA BANTING

Acceleration



V1 = 0 FT/SEC

t = 1 SEC

V2 = 32.2 FT/SEC

FINAL VELOCITY (FT/SEC) INITIAL VELOCITY (FT/SEC)

$$A = \frac{32.2 - 0}{1}$$

A: ACCELERATION (FT/SEC/SEC)

1: TIME (SEC)

= 32.2 Ft/sec/sec

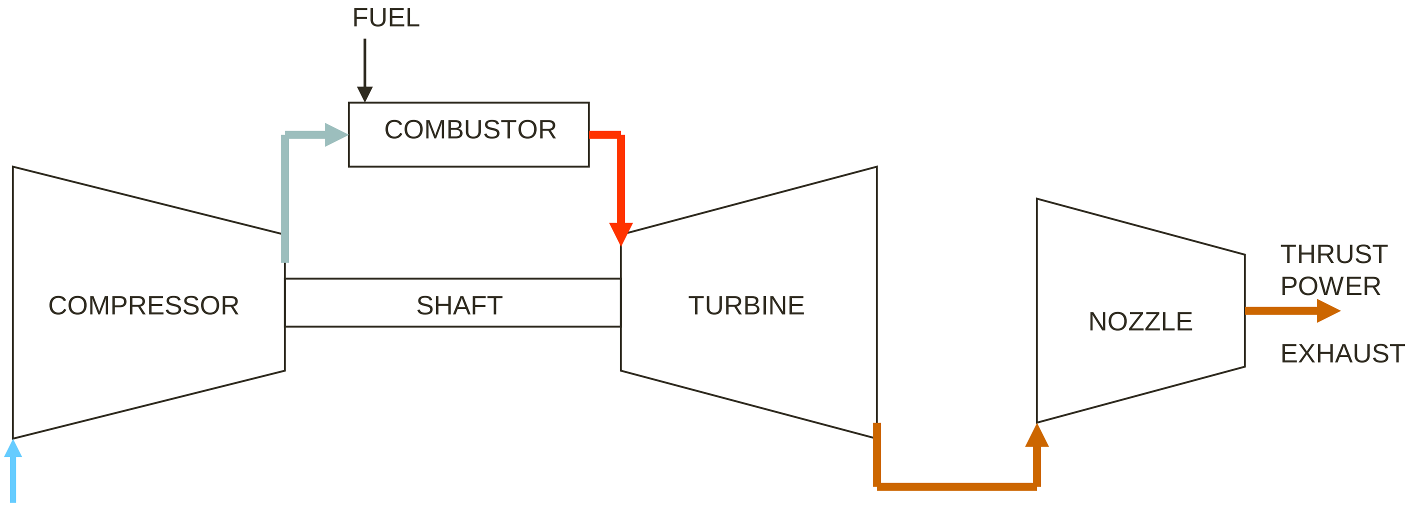
Gas Turbine Engines

Objectives:

At the end of this lesson the student will be able to recall the various types of aviation turbine engines and describe their constructional arrangement and operation.

Gas Turbine Engines

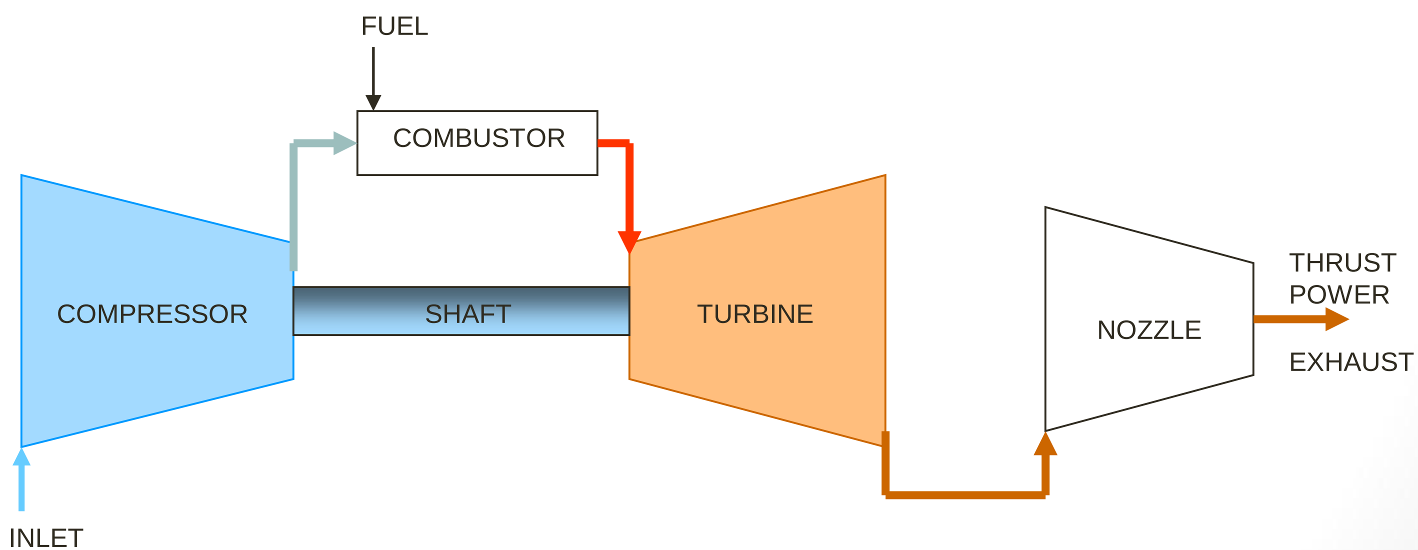
1. The engine pulls in large amounts of air, compress it and sprays fuel to it and burns it. The expanding gas leaves the engine at a high velocity to produce thrust.



POLITEKNIK MALAYSIA BANTING

Gas Turbine Engines

2. The high velocity gas also spin a turbine, which is used to drive the compressor to pull in more air to continue the cycle.



(15_1_3b.swf)

POLITEKNIK MALAYSIA BANTING

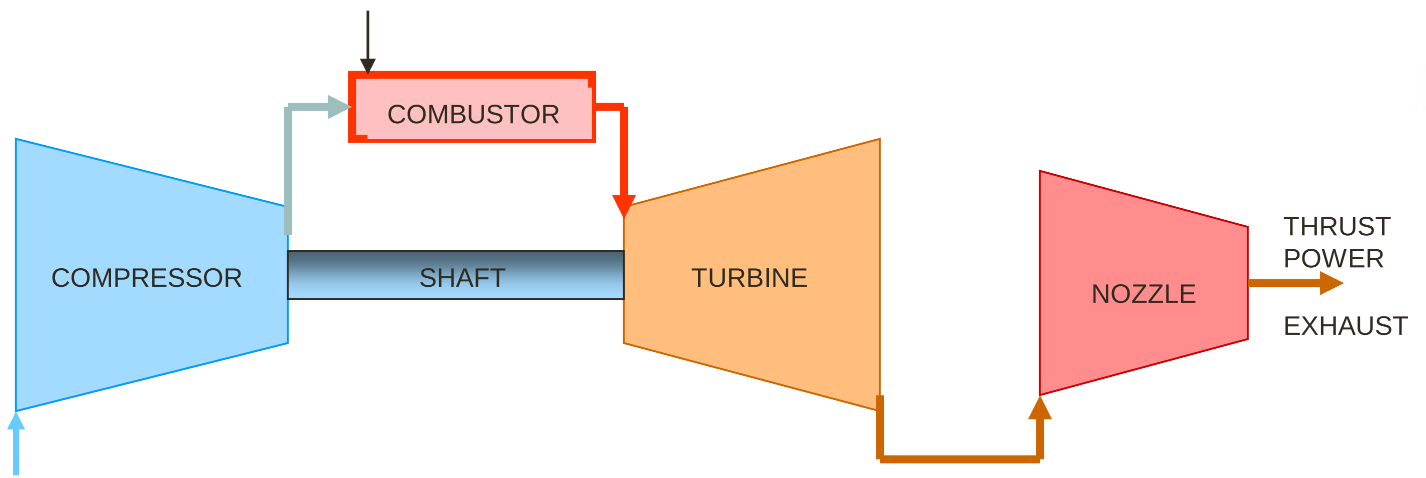
Gas Turbine Engines

Types of Gas Turbine Engines

1. Turbojet Engines

The basic components consists of the compressor, combustor and Turbine :

a. The compressor compresses the air to increase its pressure.
b. Fuel is added to the high pressure air to be burnt in the combustor.
c. As the high temperature air leaves the combustor at a high velocity, it drives a turbine, which in turn drives the compressor.
d. Energy left in the gas leaves the engine through a tail pipe at high velocity to produce thrust.



(15_1_3ca.swf)

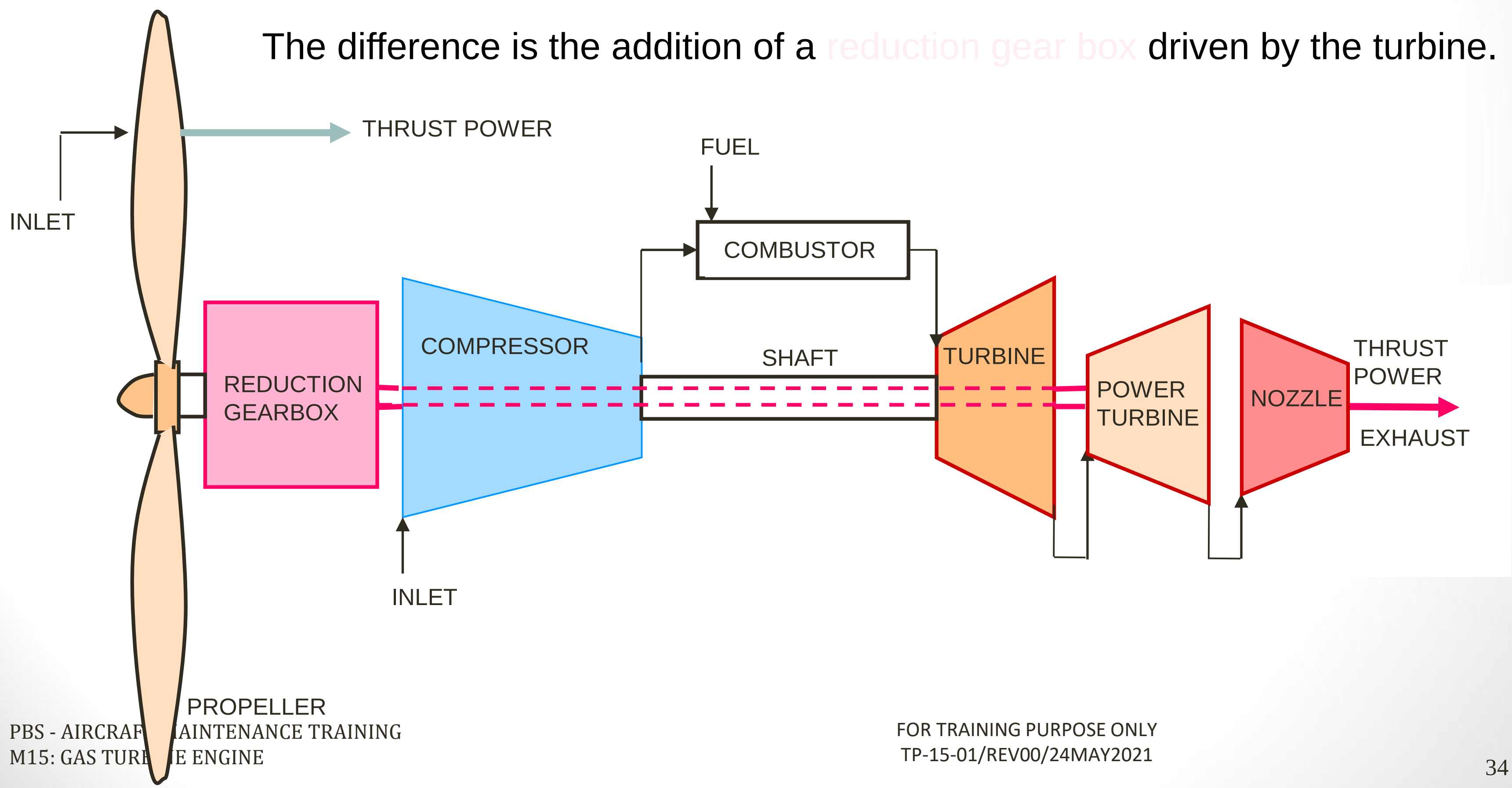
Gas Turbine Engines

Types of Gas Turbine Engines

2. Turbo Prop Engines

The basic components of the turboprop engine are identical to those of the turbojets. It has a compressor, combustor, and turbine.

The difference is the addition of a reduction gear box driven by the turbine.



Gas Turbine Engines

Types of Gas Turbine Engines

2. Turbo Prop Engines

The reduction gearbox drives a propeller. Most of the energy in the exhaust gas is used to drive the turbine, leaving approximately 10 % of the energy as reaction thrust.

The turboprop engine is most efficient for aircrafts flying at 250 to 450 mph.

(15_1_3cb.swf)

Gas Turbine Engines

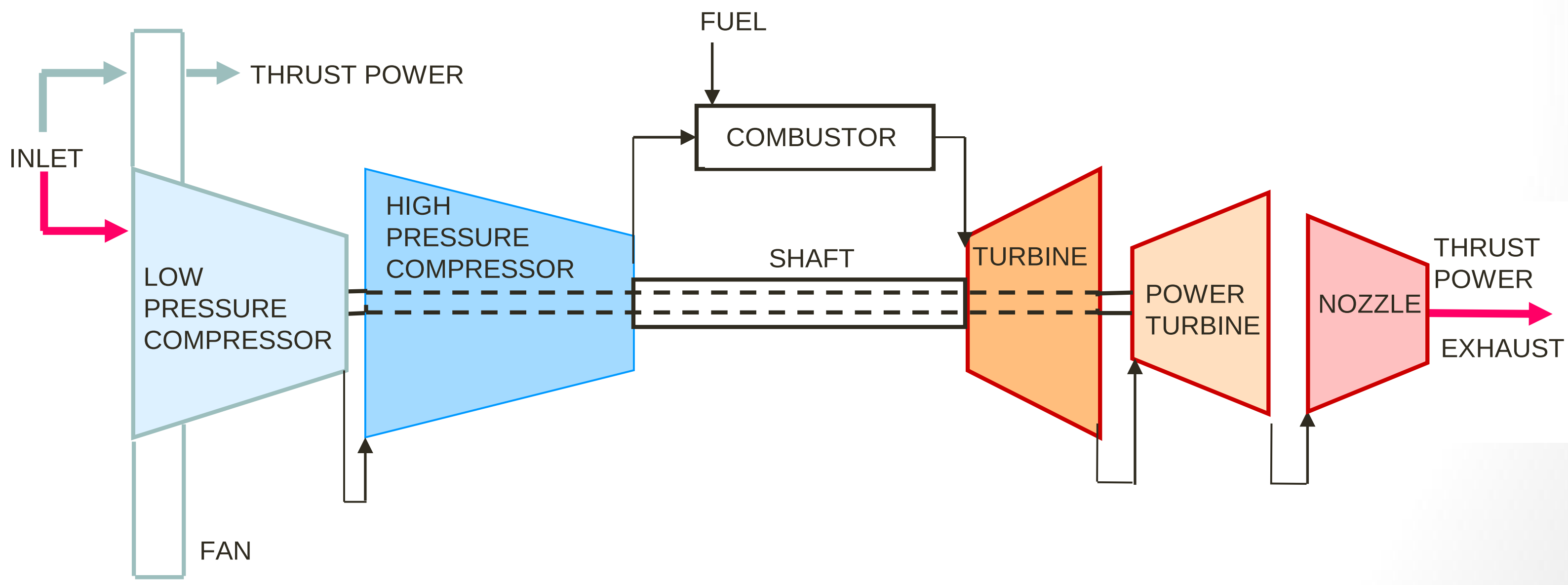
Types of Gas Turbine Engines

3. Turbofan Engines

The TurboFan Engine has 2 gas streams.

a. The Cool bypass airflow

b. The Hot primary airflow



Gas Turbine Engines

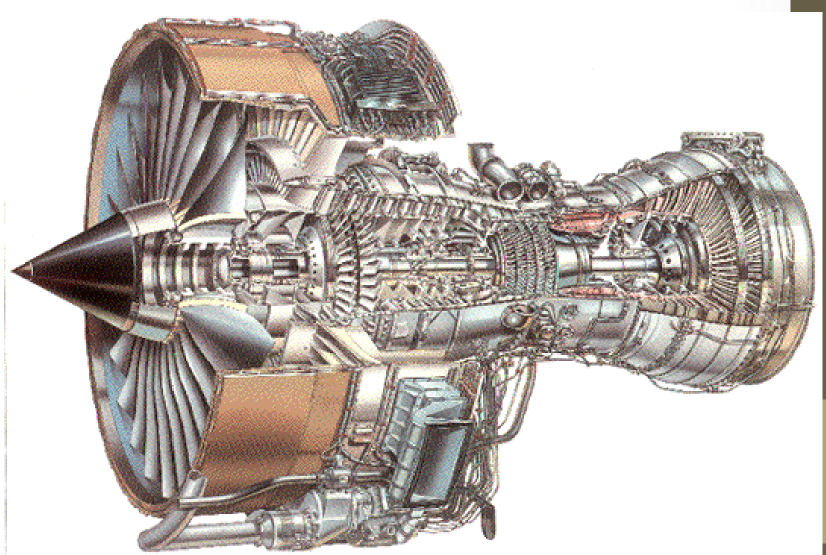
Types of Gas Turbine Engines

3. Turbofan Engines

80% of the thrust comes from the cool bypass or secondary airflow which is generated by the fan. TurboFan engines may be Hi-bypass or Low-bypass engines.

The amount of bypass air to primary air is called the bypass ratio.

The Turbofan engine is most efficient from 450 mph upwards.



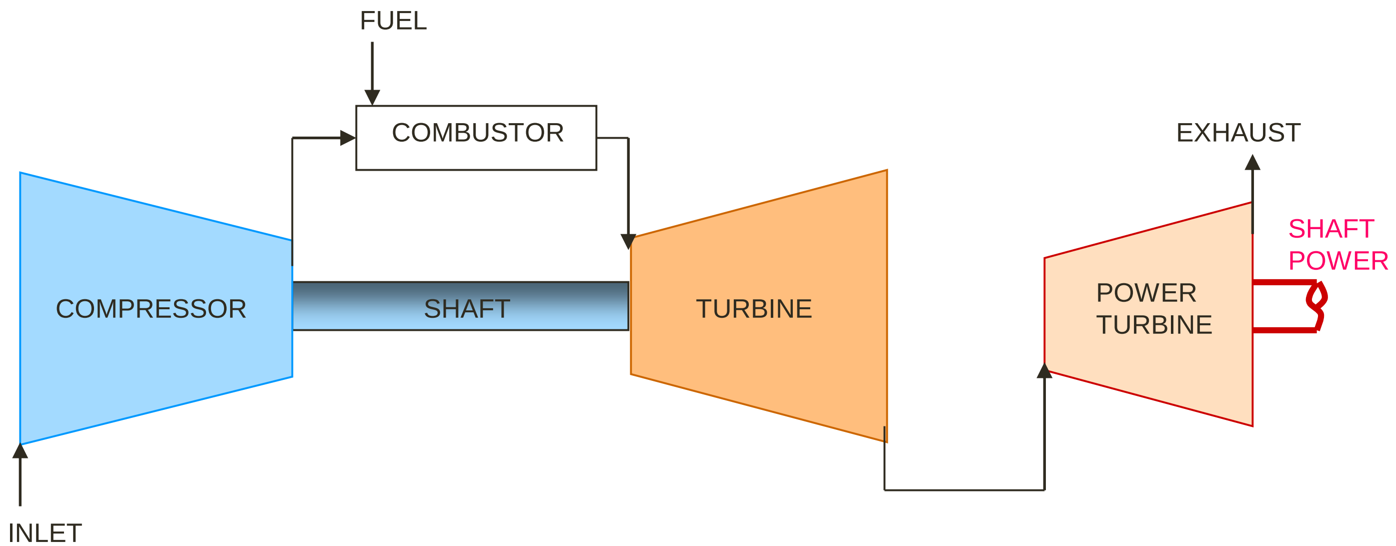
(15_1_3cc.swf)

Gas Turbine Engines

Types of Gas Turbine Engines

4. Turbo shaft Engines

A Turbo shaft engine delivers power through the shaft only.
All the energy from the exhaust air is used to drive the turbine.



Application for the Turbo shaft in Aviation are mainly for helicopters an as the APU in large Transport aircrafts.

(15_1_3cd.swf)